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Decontamination of Structures and Debris at Superfund Sites

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Two building decontamination technologies, a method for insitu degradation of PCB's requiring application of an alkali metal/polytheylene glycolate mixture directly on concrete surfaces, and a shotblasting technique using steel shot to cut away concrete surfaces were demonstrated and evaluated. Costs of large-scale implementation of each of the two techniques were calculated and compared.

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ABSTRACT

A large number of sites in the United States are contaminated with hazardous chemical residues. Many of these sites include structures (e.g., buildings, manufacturing facilities) which are contaminated with hazardous organic chemicals such as PCBs. In addition, many hazardous waste sites are littered with debris (e.g., scrap metal, equipment or furniture) which is also contaminated. Currently the common practice is to raze the structures and dispose of contaminated structural components and debris in a RCRA Subtitle C hazardous waste landfill or incinerator which is very costly. Hence, more cost effective yet environmentally-compatible methods for dealing with contaminated structures and debris are clearly needed.

In this paper we present the results of evaluating the efficacy of two technologies which have previously shown promise for removing PCBs in or on poured concrete floors. These two technologies comprise 1) in situ degradation of PCBs entailing application of an alkali metal/polyethylene glycolate mixture directly to the concrete surface, and 2) a shotblasting technique

which entails use of steel shot to cut away concrete surfaces. In order to evaluate these PCB removal techniques, concentrations of PCBs in the top ½ inch of the contaminated concrete floor were determined before and after treatment by analyzing cores obtained from selected locations on the concrete floor.

In addition to the evaluation of concrete decontamination procedures, an innovative process for decontaminating debris was also designed and evaluated. The process utilizes a hydromechanical cleaning system and a custom-designed system which continuously cleans and recycles the solution. Bench-scale experiments were performed to determine the optimal solution for cleaning PCB-contaminated, corroded iron components. We describe a 300-gallon, pilot-scale module which is being assembled and will be field-tested at a Superfund site.

KEY-WORD INDEX

Remediation
Decontamination
Superfund
PCB
Concrete
Debris
Chemical Reagent
Shotblasting

INTRODUCTION

It is well known that a large number (more than 1000) of sites in the United States are currently contaminated with hazardous wastes. Many of these sites are listed on the National Priorities List (NPL), and cleanup of at least 375 of these sites over the next 5 years has been mandated by the Superfund Amendments and Reauthorization Act (SARA), which became law on October 17, 1986.

Some of the NPL sites include structures (e.g., houses, office buildings, manufacturing facilities) which are contaminated with one or more toxic organic and/or inorganic chemicals. In addition, many hazardous waste sites are littered with debris (e.g., scrap metal, masonry materials, pieces of wood, equipment or furniture) which are also contaminated.

The materials of construction that form the load-bearing structure of most buildings typically include metal, glass, concrete, mortar, brick, stone, and wood. Other materials, such as wallboard, floor covering, and polymeric decorative materials, are also routinely used to complete the structure. No generally applicable decontamination technique has yet been devised for removing organic contaminants such as polychlorinated biphenyls (PCBs) from various materials which comprise a modern-day structure.

The facile removal of organic chemical contaminants such as PCBs from hard, smooth surfaces such as glass or certain steel surfaces is readily understood. However, the physical characteristics of rough, porous materials such as concrete and other masonry-type building materials make them difficult to clean. A recent U.S. Environmental Protection Agency publication (1) discusses various methods, including scarification, hydroblasting, and a

variety of chemical treatments for cleaning the surfaces of concrete and similar materials. Many of these methods have the disadvantage of generating large amounts of aqueous and solid waste. Moreover, the overall effectiveness of these methods has not been carefully verified. Reliable data which provide an indication of the efficacy of either established or emerging methods of decontaminating intact structures and structural components are lacking.

Therefore, a major goal of this study was to investigate the efficacy of currently available decontamination methods for removing contamination from intact buildings and restoring these structures to a usable condition. Another goal was investigation of methods that show promise for removing toxic contaminants from debris (including potentially reusable or recyclable items such as metal furniture and shelving, piping and ductwork, tanks and drums, bricks, metal wall studs, and perhaps plastic building materials). Lowering the level of contamination on the surfaces of these types of debris would permit the debris components to be removed from the site for either subsequent reconditioning and reuse, or disposal in a Subtitle D sanitary landfill or municipal incinerator (rather than a RCRA Subtitle C hazardous waste landfill or incinerator).

Phase I of this study was directed toward locating an actual contaminated site or sites that would be suitable for demonstrating various cleanup or site remediation technologies. Several sites (some NPL-listed and some non-NPL-listed) were visited and evaluated. Ultimately, two PCB-contaminated Superfund sites, the Pioneer Equipment site and the Carter Industrial site which are less than 1 mile apart in Detroit, Michigan, were selected for Phase II of this study.

In Phase II of this building and debris decontamination study, the efficacy of selected decontamination technologies for removing PCBs has been evaluated during field studies performed at the two contaminated sites in Detroit. Methods for removing PCBs on the surface and in the top ½ inch of a concrete floor at the Pioneer site were assessed in a comparative fashion.

Also during Phase II, a system for decontaminating debris was designed and assembled. Bench-scale studies were conducted in which the optimal solution for accomplishing hydromechanical cleaning of contaminated debris was determined. Based upon the outcome of bench-scale studies, a pilot-scale version of the debris cleaning system has been designed and is being constructed. The salient feature of this pilot-scale debris decontamination module will be described in the latter portion of this paper.

BUILDING DECONTAMINATION DEMONSTRATIONS AT PIONEER EQUIPMENT SITE

At the Pioneer Equipment Site, two decontamination techniques for removing PCBs were demonstrated. These two techniques were 1) a method for in situ degradation of PCBs which entails application of an alkali metal/polyethylene glycolate mixture directly to the concrete surface, and 2) a shot-blasting technique which entails use of steel shot to cut away concrete surfaces. The decontamination tests were conducted in a statistically valid manner in order to minimize both the effects of varying PCB concentrations in the floor and the subtle effects of variations in concrete composition itself on the comparison of decontamination methods.

Sampling Procedure

Prior to implementation of the two decontamination technologies, the concrete floor (which is located in an abandoned building) was divided into

sections, and each section subdivided to form test plots. Within these test plots, sampling locations were identified for baseline (pretreatment) and posttreatment sampling. More specifically, the floor was sectioned off into four 20-foot x 10-foot rectangular plots and each was then bisected to create a total of eight 10-foot x 10-foot plots. These plots were all in the northwest quadrant of the north room of the building and had a north/south longitudinal axis. Five sampling locations were identified in each of the eight test plots. Two adjacent points were marked off at each of the five sampling locations where the first point was sampled as part of the pretreatment sampling program and the second point was sampled subsequent to treatment of the test plot.

Concrete core samples were obtained using a 2-inch coring tool at each of the five sampling locations in each test plot. Each concrete core had a diameter of approximately 1.75 inches. From each of these eight plots, five core samples were obtained for a total of 40 samples. The top ¼ inch of 24 of the 40 samples (i.e., 3 per plot) were analyzed for PCB content. The remaining 16 core samples (2 from each plot) were each divided into two sections (the top ¼ inch and the next ¼ inch, thus creating 32 samples) and each section were subsequently analyzed for PCBs. Thus, a total of 56 sample analyses were completed prior to implementing the two decontamination procedures.

After the completion of the two decontamination technologies, another 40 core samples were obtained from locations on the floor that were as close as possible to the original sampling locations. The samples were sectioned and analyzed as described for the pretreatment samples, resulting in another set of 56 analyses. The locations of the top ¼ inch and the next ¼ inch core samples are shown in Figures 1 and 2, respectively.

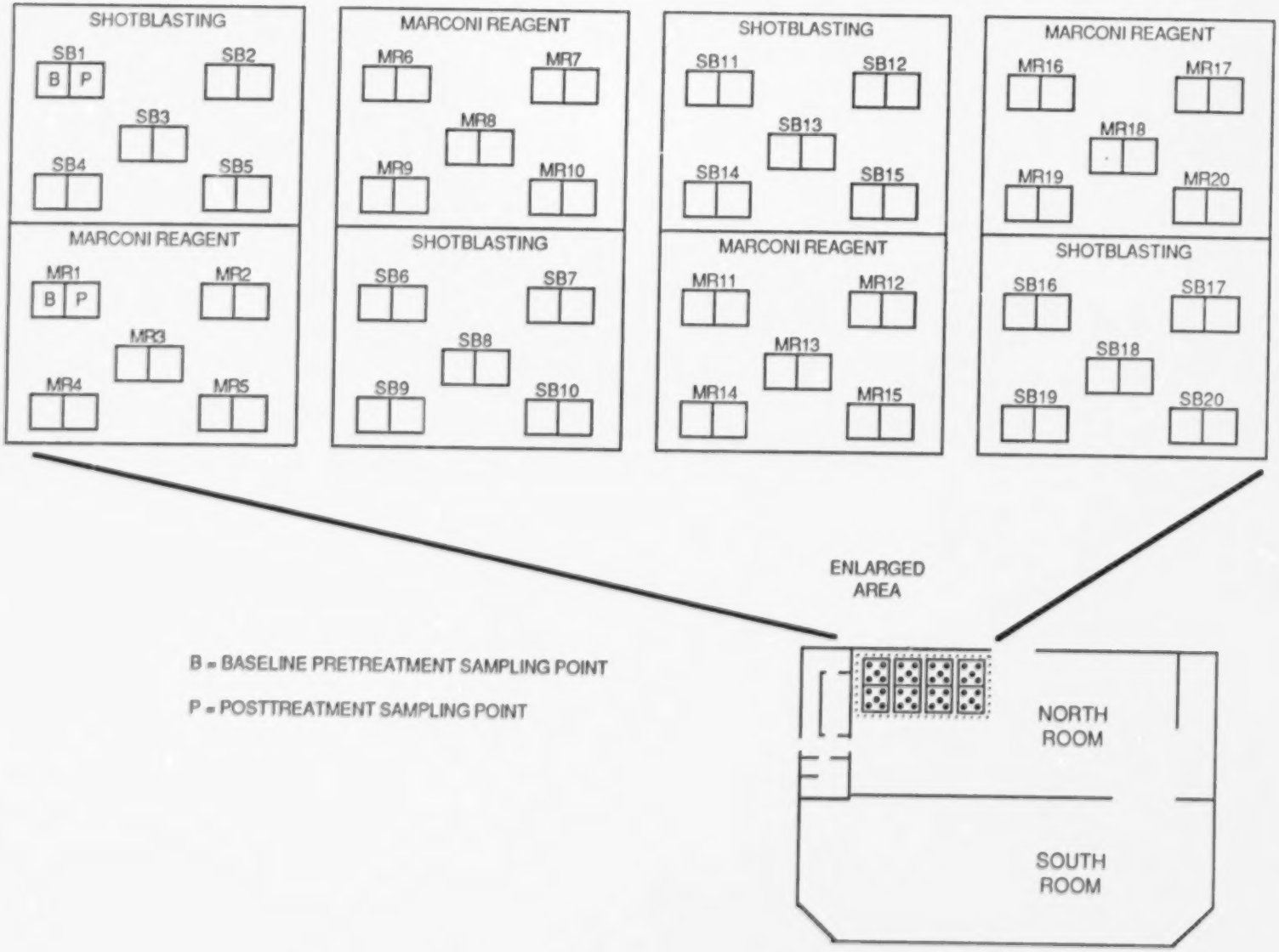

Figure 1. Sampling locations of the top 1/4 - inch core samples.

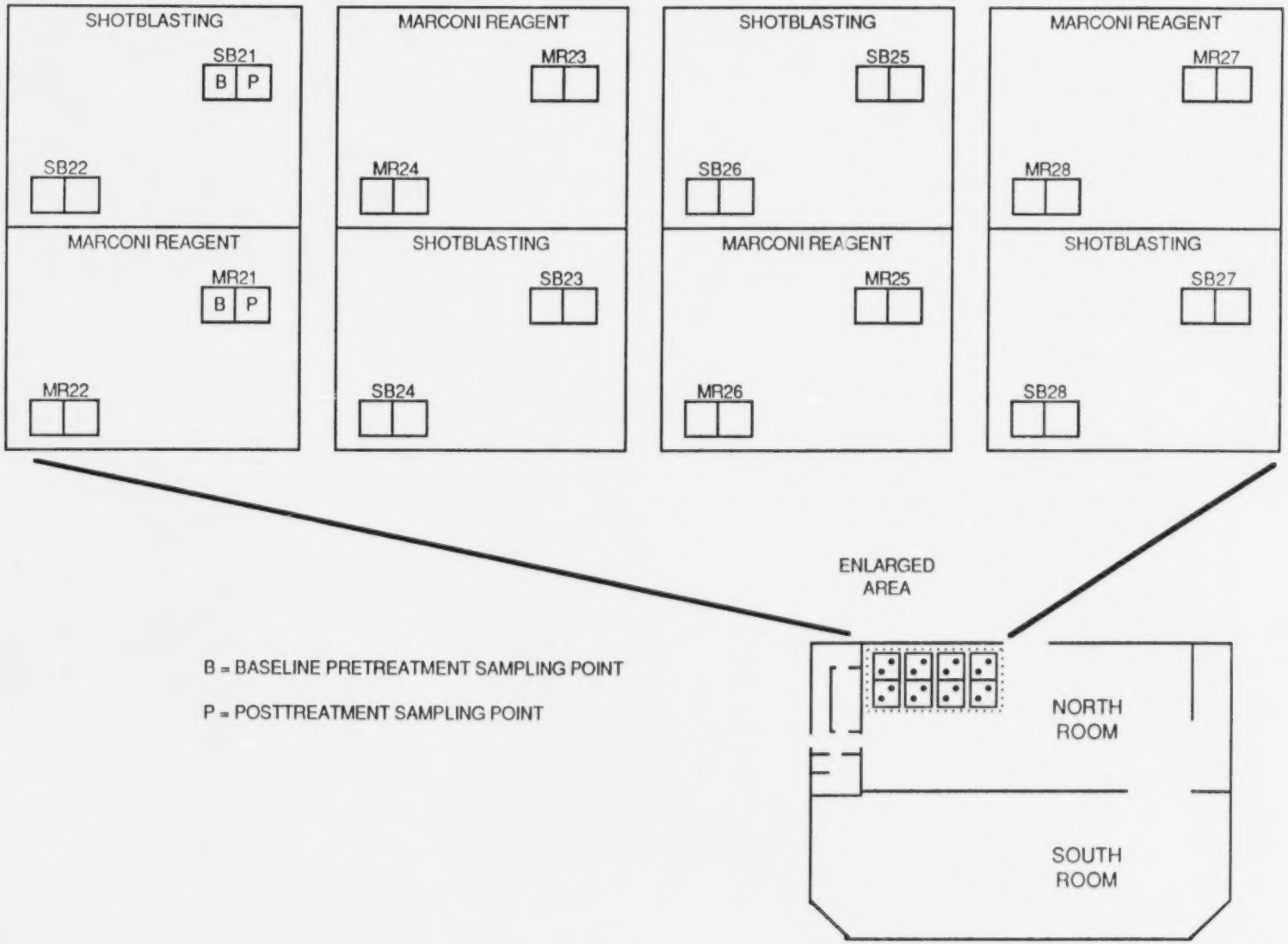

Figure 2. Sampling locations of the next 1/4 - inch core samples.

Demonstration of the IT/SEA Marconi Reagent: Methodology and Results

The chemical reagent, also called the IT/SEA Marconi reagent, is a polyethylene glycol-based mixture. The reagent was initially heated in a waterbath and then applied to the concrete surface using a sprayer or brush. Typically, the reagent is allowed to remain in place for 2 to 3 weeks. In previous studies, the liquid penetrated up to 2 inches, where it contacted the PCB and reacted to form non-PCB byproducts.

During the technology demonstration at the Pioneer Equipment Site, cans of IT Marconi reagent were heated in a waterbath to a temperature of 180° to 190°C. When the reagent reached the correct temperature, a small amount of hot reagent was poured onto the concrete floor within designated test plots and was spread evenly using a roller. This process of applying the reagent was repeated two additional times at 24 hours and 48 hours following the initial application of reagent. The reagent was then allowed to dry for a period of 2 weeks.

After 2 weeks, 20 posttreatment core samples were collected from the areas that had been treated with the Marconi reagent and were analyzed for PCBs.

The concentrations of PCBs in the top ½ inch of concrete before and after the application of IT/Sea Marconi reagent are summarized in Table 1. The apparent reduction in PCB concentration ranges from 11 to 97 percent (average reduction of 73 percent), and these results seem to indicate that the reagent was able to penetrate into the concrete floor and reacted with PCBs. The penetration of the reagent into concrete and reaction with PCBs is supported by the results obtained for the next ½ inch of concrete, as shown in Table 2. In this latter table, the percentage reduction in PCB concentration ranges from 66 to 99 percent (average reduction of 91 percent).

TABLE 1. CONCENTRATION OF PCBs IN A SURFACE (TOP ½ INCH) OF CONCRETE BEFORE AND AFTER SEA MARCONI REAGENT (ppm)

Sample No.	Pretreatment	Posttreatment	% Reduction
MR1	52.0	3.67	93
MR2	6.5	2.46	62
MR3	22.0	0.64	97
MR4	5.7	1.58	72
MR5	8.3	2.79	66
MR6	6.5	2.35	64
MR7	9.2	1.96	79
MR8	42.4	1.43	97
MR9	22.1	1.94	91
MR10	23.3	1.58	93
MR11	33.2	5.03	85
MR12	21.7	3.25	85
MR13	50.0	5.45	89
MR14	19.8	5.63	72
MR15	39.8	6.22	84
MR16	4.6	3.04	34
MR17	8.1	4.12	49
MR18	60.0	5.82	90
MR19	10.2	9.10	11
MR20	12.3	5.48	55

TABLE 2. CONCENTRATION OF PCBs IN A SURFACE (NEXT ½ INCH) OF CONCRETE BEFORE AND AFTER SEA MARCONI REAGENT (ppm)

Sample No.	Pretreatment	Posttreatment	% Reduction
MR21	3.5	0.23	93
MR22	5.0	0.23	95
MR23	6.3	0.21	97
MR24	13.0	0.10	99
MR25	4.1	1.41	66
MR26	1.8	0.35	80
MR27	2.7	0.10	96
MR28	3.0	0.01	99

On the basis of this rather limited study, it appears that the IT/Sea Marconi reagent has some beneficial effect upon PCBs which are on the surface of or perhaps contained within the upper ½ inch of a concrete floor.

Additional studies involving more analyses of concrete prior to and after application of the reagent should be performed to corroborate these initial findings. Furthermore, additional work is needed to determine the optimum reaction conditions for the IT/Sea Marconi reagent.

Demonstration of the Shotblasting Process: Methodology and Results

Shotblasting is a destructive procedure that may be used to remove surface layers of contaminated concrete. By selecting the shot size and the rate at which the machine traverses the concrete surface, one can control the amount of concrete removed from the surface of a concrete floor. Typically, a 1/16- to 1/8-inch layer of concrete can be removed by the shotblaster. (Note: The shot blasting machine used in this study was Blastrac Model 1-10D with a Model 554-DC dust collector.) The machine is equipped with a HEPA-filtered vacuum system that captures nearly all of the particulate generated during shotblasting. The captured dust is periodically removed from the vacuum system of the shotblaster and transferred to barrels for subsequent disposal. Despite the HEPA-filtered vacuum system, use of the shotblasting process may generate airborne debris, which has the potential for cross-contamination of test plots. Therefore, the shotblasting evaluation at the Pioneer Equipment Site was commenced after all activities related to the evaluation of the IT/Marconi reagent were completed.

Designated test plots on the concrete floor (see Figures 1 and 2) were shotblasted and a minimum of 0.125 to 0.250 inch of concrete was removed.

Fugitive dust generated by the process that was not captured by the vacuum system was gathered and vacuumed separately, and disposed of as contaminated concrete material. Following shotblasting, 20 posttreatment core samples were collected.

The concentrations of PCBs in the top ¼ inch surface of concrete before and after the shotblasting process are summarized in Table 3. The percentage reduction in PCB concentration after shotblasting ranges from 19 to 96 percent, (average reduction of 68 percent) which indicates that the technique is fairly effective in removing PCBs from the surface of the concrete floor. However, in two samples (SB2 and SB11) the PCB concentration apparently increased after shotblasting treatment. This apparent increase is most likely due to the fact that the post-treatment samples were, in the case of these two samples, obtained from locations on the floor which were initially more heavily contaminated with PCBs. The posttreatment analyses of the next ¼ inch of concrete is in progress and are expected to have a similar trend as that obtained for the top ¼ inch of concrete.

These results indicate that in the case of the PCB-contaminated floor at the Pioneer site, PCBs in the top ¼ to ½ inch of the concrete floor are, as expected, effectively removed by shotblasting. Of course, further analyses should be performed to determine the depth of penetration of PCBs into the concrete. Conceivably, the concrete could be repetitively shotblasted until no significant levels of PCBs remain.

Only a small amount of fugitive dusts were generated by the shotblasting process. At least 95 percent of the concrete dust was captured by the vacuum system, which is an integral part of the machine. In total, 1000 square feet of concrete were shotblasted and approximately a 1/8- to 1/4-inch layer of concrete was removed. The total quantity of dust amounted to two barrels.

TABLE 3. CONCENTRATION OF PCBs IN A SURFACE (TOP ¼ INCH) OF CONCRETE BEFORE AND AFTER SHOTBLASTING PROCESS (ppm)

Sample ID	Pretreatment	Posttreatment	% Reduction
SB1	4.4	3.0	32
SB2	0.13	1.5	-1054
SB3	65.0	2.52	96
SB4	7.7	3.17	59
SB5	26.0	2.11	92
SB6	17.2	6.92	60
SB7	11.8	5.44	54
SB8	35.7	6.3	82
SB9	13.4	3.4	75
SB10	4.6	3.91	15
SB11	1.6	1.86	-16
SB12	4.4	2.75	38
SB13	4.7	1.97	58
SB14	23.5	1.56	93
SB15	3.2	1.41	56
SB16	25.0	4.84	81
SB17	22.8	1.28	94
SB18	21.4	5.38	75
SB19	40.9	8.15	80
SB20	42.5	7.78	82

DEBRIS DECONTAMINATION DEMONSTRATION AT THE CARTER INDUSTRIAL SITE

The demonstration of debris decontamination at Carter Industrial entails the use of an trailer-mounted Experimental Debris Decontamination Module (EDDM). This is compact and transportable by a truck. The module will include a recirculating liquid delivery system which will allow debris to be washed with an aqueous solution containing a detergent. The solution will be recycled through a closed-loop cleaning system which permits the solution to be reused, thus minimizing the volume of liquid employed to clean debris.

Bench-Scale Experiments

Prior to finalizing the details of the design of the EDDM, a bench-scale experiment was performed to determine the best cleaning solution for possible use to clean PCB-contaminated debris and metal parts in the field. Four cleaning solutions were selected for the experiment, namely, water, sulfuric acid, and the detergents BB-100 and Power Clean.

The experimental procedure involved the application of measured quantities of used motor oil, grease, and soil to rusted iron parts to simulate the kind of grime that is likely to be encountered on oily, PCB-contaminated, metal parts and debris in the field. Experiments were performed in a 10-gallon hydromechanical cleaning unit, which contains an axial flow pump, a propeller shaft, a propeller, a pressure chamber, and a calm fluid section. Three tests were performed with each cleaning solution, and a fresh set of oil/grease contaminated metal parts were employed for each test. For consistency, each set of contaminated parts was matched closely with regard to the size, shape, and type of metal. The parts were arranged in the same order in parts-washer basket during washing.

At the completion of each test, two aliquots of cleaning solution were collected, one aliquot was submitted for oil and grease analysis and another for total suspended solids analysis. Two surface wipe samples from selected metal parts were also collected for oil and grease analysis to determine the level of oil/grease remaining on the metal surfaces after treatment in the parts washer. The skimmer oil from each of the three runs was mixed together for oil and grease analysis.

The results of the oil/grease and total suspended solids analyses are summarized in Table 4. The analytical results of the wipe samples indicate that, after cleaning, the amount of oil and grease on the metal surfaces was significantly higher in the case of water or sulfuric acid and comparatively lower for BB-100 and Power Clean. This indicates poor cleaning performance of water and sulfuric acid. Moreover, the handling of 10 percent sulfuric acid was difficult, and it also had a corroding effect on the hydromechanical cleaning equipment. Hence, it was concluded that water and sulfuric acid should not be considered as a potential cleaning solution for oily PCB-contaminated debris.

Based upon the results of the surface wipe testing listed in Table 4, a BB-100 solution is a better cleaning solution than a Power Clean solution. This is shown graphically in Figure 3, which plots the results of wipe samples (in milligrams of oil and grease/square centimeter) for each run. Table 4 results also show that BB-100 removed solids from metal surfaces more effectively than Power Clean. The data also show that at the completion of third run, the BB-100 solution still had more cleaning capacity to remove dirt from metal parts than did Power Clean. Hence, of the four cleaning

TABLE 4. SUMMARY OF RESULTS OF OIL/GREASE AND TOTAL SUSPENDED SOLIDS ANALYSES

Experimental run No.	Sample type[a]	Analysis	Cleaning solution			
			Water	Sulfuric acid conc. 10%, wt./vol.	BB-100 conc. 15%, v/v	Power Clean conc. 1:6 ratio
1	Cleaning solution	Oil and grease, mg/liter	42	161	7	1670
2	Cleaning solution	Oil and grease, mg/liter	151	143	182	1470
3	Cleaning solution	Oil and grease, mg/liter	241	138	319	2440
1	Cleaning solution	Total suspended solids, mg/liter	5	128	600	206
2	Cleaning solution	Total suspended solids, mg/liter	7	255	904	576
3	Cleaning solution	Total suspended solids, mg/liter	15	148	1000	484
1	Wipe No. 1	Oil and grease, mg/cm^2	1.77	1.48	0.32	0.50
1	Wipe No. 2	Oil and grease, mg/cm^2	1.82	1.75	0.25	0.49
2	Wipe No. 1	Oil and grease, mg/cm^2	10.54	0.7	0.15	0.43
2	Wipe No. 2	Oil and grease, mg/cm^2	4.40	4.8	0.42	0.48
3	Wipe No. 1	Oil and grease, mg/cm^2	2.43	3.81	0.26	0.34
3	Wipe No. 2	Oil and grease, mg/cm^2	-	3.27	0.33	0.61
Total of 1, 2, & 3	Oil from skimmer	Oil and grease, mg/liter	-	1540	3380	3900

[a] All samples are post-treatment samples.

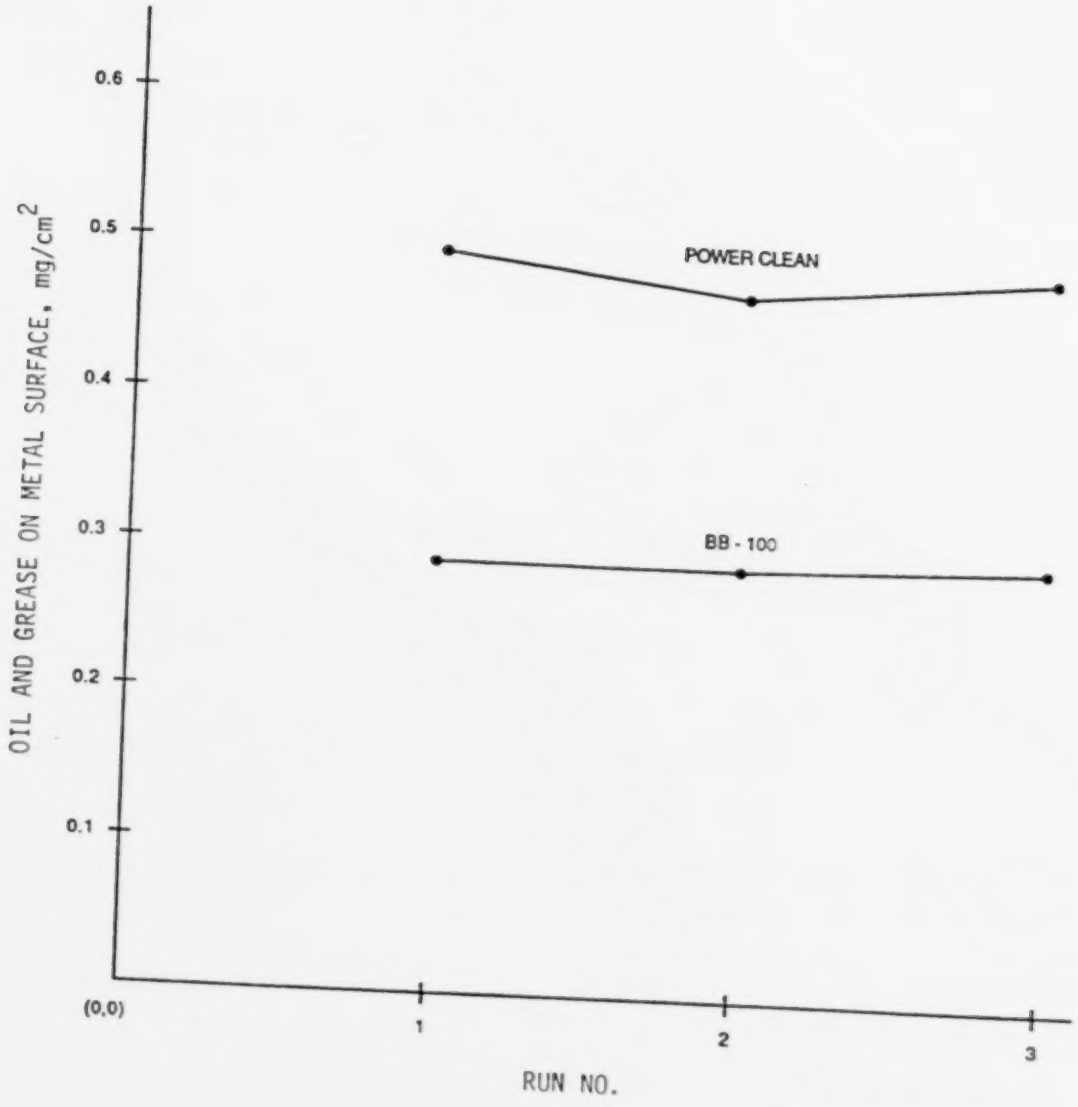

Figure 3. Amount of oil and grease on metal surface after completion of cleaning cycle.

solutions tried, BB-100 was selected as the cleaning solution best suited for cleaning oily PCB-contaminated metal parts and debris in the field.

Pilot-Scale Module

At present, a 300-gallon capacity EDDM has been assembled and will be field-tested in September 1988 at the Carter site. Metallic debris items will be selected and five to ten wipe samples will be obtained and analyzed for PCBs. The debris items will be placed into a basket and then will be transferred into the EDDM and the cleaning process will be instituted. The cleaning solution will be cycled through a continuous, closed-loop system in which the oil/PCB contaminated wash solution will be passed through oil/water separator and the clean solution will then be recylced into the module. At the completion of the cleaning process, five to ten additional wipe samples will be obtained to assess the post-decontamination level of PCBs on the surface of the debris. The liquids resulting from the decontamination of debris in the EDDM (and decontamination of the EDDM itself) will be treated and disposed of. Figure 4 represents a flow-diagram of the pilot-scale module.

CONCLUSIONS

The results obtained from IT/Sea Marconi reagent and shotblasting processes indicate that both of these technologies show a great deal of promise for removing PCBs from the surface of the concrete floor. In the case of both of these technologies, a wide range in percentage of reduction in PCB concentration was noticed. This wide range could be due to the variation of PCB concentration on different locations of the floor.

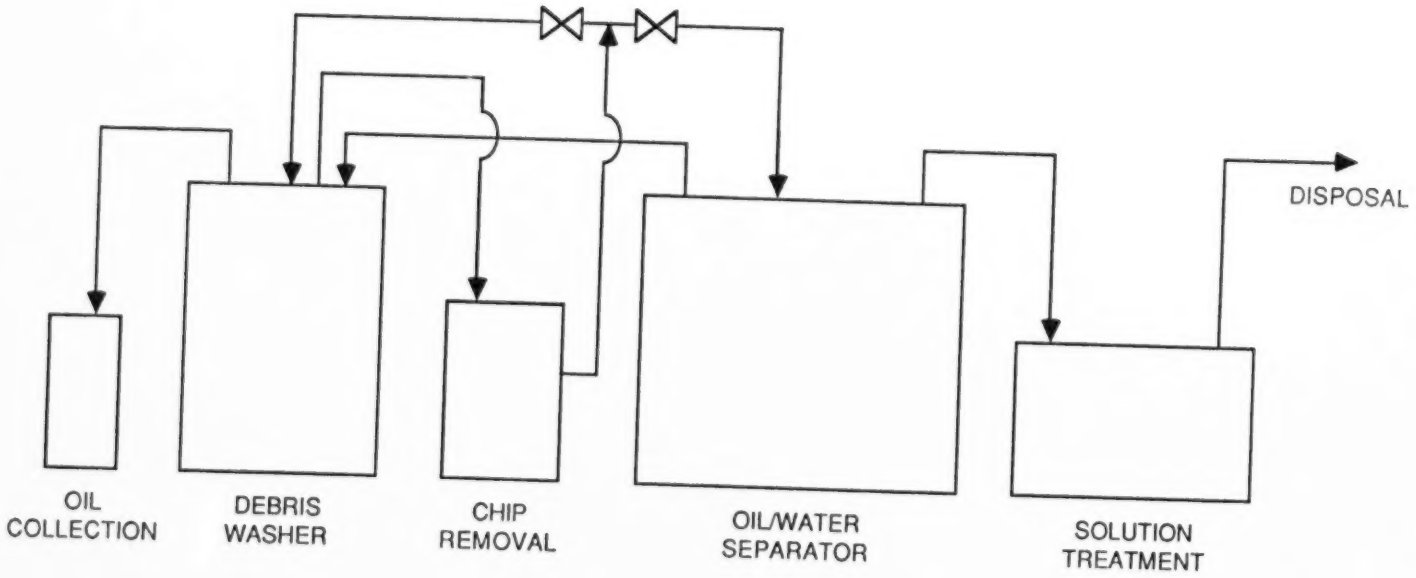

Figure 4. Pilot - scale process flow diagram.

Under the condition in which Sea Marconi reagent was used, it has shown some beneficial effect upon PCBs. The Marconi reagent method is very easy to use and does not generate any waste. However, additional work is needed to corroborate these initial findings.

The results of the shotblasting demonstration are very promising and indicate that this technique is effective for removing PCBs from the surface of the concrete floor. For a heavily-PCB-contaminted floor, repetitive shotblasting can significantly reduce the PCB concentration. The advantage of the shotblasting process was that almost 95 percent of the concrete dust was captured by the machine's vacuum systems and only a small amount of fugitive dusts were generated.

The study of the Experimental Debris Decontamination Module (EDDM) is in progress and the results will be available by November 1988.

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REFERENCES

1. Esposito, M. P., J. L. McArdle, A. H. Crone, J. S. Greber, R. Clark, S. Brown, J. B. Hallowell, A. Langham, and C. D. McCandlish. Guide for Decontaminating Buildings, Structures, and Equipment at Superfund Sites. EPA Report No. 600/1-85/028, U.S. Environmental Protection Agency, Cincinnati, Ohio, January 1985.